IRRIGATION METHOD

CROSS REFERENCE TO RELATED APPLICATIONS

This application is an application filed under 35 U.S.C. §111(a) claiming benefit pursuant to 35 U.S.C. §119(e)(1) of the filing date of the Provisional Application 60/050.032. filed Jun. 18. 1997. pursuant to 35 U.S.C. §111(b).

FIELD OF THE INVENTION

This invention relates to the irrigation of large crop areas by spraying water onto the crop area.

BACKGROUND TO THE INVENTION

It is common practice to irrigate crop areas in those regions where there is a shortage of rainfall. One method of irrigation is by furrow irrigation. A problem with furrow irrigation is that the irrigation water flowing along the furrow is liable to erode the furrow. Also infiltration of the water through the furrow may not be as efficient as is desired. It is known to include synthetic polymer in the furrow irrigation water. the polymer often being the type which is commercially available for improving the structure of soil by direct application of the polymer to the soil. Furrow irrigation processes using such polymers are described particularly in WO96/102126.

Another way of irrigating crop areas is by spraying water onto the area. Because there is no deliberate flow of water along the surface. it might be thought that erosion would not be a problem. However erosion problems can occurs especially when the irrigated area is on a slope. Also infiltration may not be as efficient as is desirable. especially when the irrigated soil is allowed to dry out between irrigations. for instance as is likely to occur in large pivot irrigation systems where there may be a day or more between irrigations. Also not all the spray water is effective for irrigation. for instance due to run-off or evaporation.

It would be desirable to be able to minimise these deficiencies in large-scale spray irrigation.

It might be thought that introduction of polymers. for instance of the type known as soil conditioners. into the irrigation water would be beneficial. Unfortunately existing methods are not practicable.

Polymers are generally supplied initially as a powder or as a reverse phase emulsion (i.e. a dispersion of polymer particles in a non-aqueous liquid. generally oil). The normal industrial practice is to mix the powder or the reverse phase emulsion with water in special dissolution apparatus so as to form an aqueous solution of the polymer having a concentration of. for instance. 0.2 to 2% by weight and this solution is then dosed into the water which is to be treated by the polymer.

However the manufacture of this solution necessitates the provision of special make-up apparatus. It is impracticable to provide this make-up apparatus at the crop area. and if the solution is made up at a point distant from the crop area it is then necessary to transport the solution to the crop area and this is inconvenient because of the large volume of the solution.

SUMMARY OF THE INVENTION

The invention provides a method of irrigating a large crop area by pumping water through feed ducting and a mixing zone to a spray manifold supplying one or more spraying devices by which the water is sprayed onto the crop area. and in this method a substantially stable dispersion in a liquid of water soluble polymer particles is metered at a predetermined rate of 0.5 to 30 ppm into the water at or before the mixing zone and the polymer particles are substantially completely dissolved into the water before the water is sprayed from the spraying devices.

The crop area is normally at least 1.000 m^2 (0.1 hectare ha) but can be at least 1 ha or more and even up to 100 ha.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is intended to be applied to methods in which a large crop area is irrigated by a single spray apparatus. This is important because the invention relies in part on the high rate of flow of the water to the spray apparatus. and this high rate of flow is necessarily associated with a single spray apparatus being used to spray a relatively large crop area.

The polymer dispersion can be mixed into the water supply at any convenient point as the water flows through feed ducting which leads eventually to the spray manifold. Thus the polymer can be added to the irrigation water at a point distant from the spray apparatus which is mounted in the crop area and which includes the spray manifold. However the dispersion is usually best added to the irrigation water at the spray apparatus which is mounted in the crop area. This spray apparatus typically comprises a housing. a water inlet to which feed ducting can be attached. the spray manifold and a water supply passage leading from the inlet to the spray manifold. In the invention. a mixing zone is provided in the water supply passage between the inlet and the manifold and the dispersion is preferably metered into this mixing zone or into the passage an the inlet side of the mixing zone.

The preferred type of spray apparatus is a pivot irrigation apparatus. in which one or more spraying devices extend from the spray manifold in the form of elongated arms that pivot slowly around the spraying apparatus. Typically each of these arms may have a length of. for instance. 100 to 500 meters or sometimes even more.

When the spraying device is an elongated spraying member which has a plurality of spray orifices distributed along its length (for instance as in a pivot irrigator) the spray orifices are usually relatively coarse. for instance having a diameter at least 2 or 3 mm and frequently as much as 5. 10 or even 15 mm or more. This is advantageous in the invention since it minimises the risk of blockage of the orifices by improperly dissolved polymer.

The irrigation apparatus can. instead. be a water gun. for instance where the spray apparatus has a manifold leading to a single water gun. or a plurality of water guns. that pivot about the apparatus. The high ejection pressure of water guns again minimises the risk of any blockage due to polymer.

In general. the invention is applicable to a wide variety of spraying irrigation systems including pivot irrigators. land wheels and water guns.

The area that each spraying apparatus irrigates by spraying may be as low as 500 m^2 but is usually at least 1000 m^2 (1 ha) and frequently 10^4 to $10^6 m^2$ or even more for very large pivot irrigators. The area can be for instance at least 10 ha. preferably at least 20 ha or even at least 50 ha and in some cases at least 70 ha. It can be up to 100 ha.

The water pressure in the mixing zone is usually at least 30 psi and frequently at least 50 psi. It is generally below

100 psi. The rate of flow will depend on the area which is to be irrigated but is usually above 300 US gallons per minute and preferably above 600 US gallons per minute. This high throughput of relatively high pressure water makes it easy to generate very turbulent mixing conditions in the mixing zone so as to achieve rapid distribution of the dispersed polymer particles through the water, and rapid dissolution of the particles into water. Often there is a filter between the water inlet to the spray apparatus and the spray manifold. This filter may cause sufficient mixing, in which event the polymer should be fed into the water between the inlet and the filter, the region from the point of addition of the polymer to the spray manifold then being the mixing zone.

If the filter or other equipment which is in the apparatus anyway does not give sufficient turbulence to achieve adequate mixing, then additional baffles can be fixed within the feed passage so as to promote the turbulence and thus promote the mixing and dissolution of the polymer into water.

The polymer dispersion can be a conventional reverse phase emulsion of the relevant polymer, namely a reverse phase emulsion of aqueous polymer particles dispersed (often below 10 μm in size) in a non-aqueous liquid. Typically this emulsion contains 20 to 40% water (in the polymer particles), 20 to 40% polymer (dry weight) and 20 to 40% by weight of the non-aqueous liquid. This non-aqueous liquid can be a hydrocarbon or other hydrophobic liquid. Preferably, however, the dispersion is a reverse phase emulsion of substantially anhydrous particles of the polymer dispersed in the non-aqueous liquid. Such dispersions typically contain 35 to 65% by weight polymer and 35 to 65% by weight non-aqueous liquid and 0 to 15%, often 0 to 10%, by weight water.

Irrespective of whether the dispersion is anhydrous or aqueous, those dispersions in non-aqueous liquid preferably include an oil-in-water emulsifier in order to promote the emulsification into the irrigation water of the oil phase, so as to facilitate dissolution of the polymer particles into the water. Inclusion of such emulsifiers in reverse phase emulsions is known for promoting the dissolution of polymer when using special make-up apparatus, and any of the emulsifiers known for this purpose can be used.

Instead of using a dispersion in a non-aqueous liquid, it can be particularly preferred to use a dispersion of the polymer particles in an aqueous liquid. Since water soluble polymer particles are soluble in water, the aqueous phase of this dispersion has to contain a solubilisation inhibitor. This solubilisation inhibitor must be concentration-dependent, in order that it inhibits dissolution of the polymer particles into the aqueous phase when the aqueous phase has a high concentration of the solubilisation inhibitor, but permits dissolution of the polymer particles into water when the concentration of the solubilisation inhibitor is significantly reduced, i.e. when the dispersion is mixed into the irrigation water.

The concentration-dependent solubilisation inhibitor may consist of a single material or a mixture of materials. It is particularly preferred that part at least of the inhibitor should be a fertiliser, since this results in the irrigation water supplying both irrigation and fertilisation. The dissolution of many of the relevant polymers is inhibited by the presence of an electrolyte as part or all of the solubilisation inhibitor and so preferably an electrolyte which is a fertiliser is included in the aqueous phase of the stable dispersion. For instance the aqueous phase may include ammonium sulphate, other ammonium, phosphate and/or potassium salts can also be used as electrolyte fertiliser components.

Instead of or in addition to using inorganic electrolyte as part or all of the solubilisation inhibitor, various polymeric materials can be used. They may be nonionic or ionic. For instance the dispersion can be made by the techniques, and using the materials, described in U.S. Pat. No. 4,380,600 of Hosoda et al.

Such dispersions have a microscopic particle size, generally below 30 μm and preferably below 10 μm. It is also possible in the invention to use coarser particle sizes (at least as starting material), provided the dispersion remains sufficiently stable to be used in the invention. By this we mean that the dispersion does not settle out unacceptably (such that it cannot easily be redispersed by simple stirring), during transport and storage. Accordingly, particularly preferred compositions are compositions made by dispersing the chosen polymer particles into an aqueous solution of a polymer, optionally or preferably containing fertiliser electrolyte or other salt, for instance as described in EP-A-0169674 and of Farrar et al, assigned to Allied Colloids Limited.

The disclosure of the all the aforementioned US and European patent specifications is incorporated herein by reference.

Naturally any polymer which is utilised as part or all of the solubilisation inhibitor must be a polymer which does not interfere with the beneficial performance of the particulate polymer.

A preferred way of providing the substantially stable dispersion is by mixing, often with milling, polymer fines having a particle size generally below 200 μm into an aqueous solution of the solubilisation inhibitor.

The particulate polymer which is milled into the aqueous phase or is otherwise provided as a dispersion in a liquid phase can be any water soluble polymer which will provide beneficial results when sprayed onto the crop area. Usually it is a synthetic polymer made by polymerisation of water soluble ethylenically unsaturated monomer or monomer blend. The monomers may be selected from non-ionic, anionic and cationic monomers. Intrinsic viscosity (measured by a suspended level viscometer at 20° C. in 1 N sodium chloride buffered to pH 7) is usually at least 2 and preferably at least 4 dl/g. Often it is at least 8 or 10 dl/g, for instance up to 30 dl/g or even more in some instances.

Although the polymer can be cationic (provided it is toxicologically acceptable) the preferred polymers are usually non-ionic or anionic and thus are generally made from 0 to 70% by weight anionic monomer and 100 to 30% by weight non-ionic monomer. The non-ionic monomer is usually acrylamide but any other toxicologically acceptable ethylenically unsaturated, water soluble, non-ionic monomer can be used. The anionic monomer is usually an ethylenically unsaturated carboxylic or sulphonic monomer (often as the sodium salt) and most usually is sodium acrylate. Preferred polymers are formed by 10 to 50% by weight sodium acrylate with the balance being acrylamide.

It is important in the invention that the substantially stable dispersion should be metered at a predetermined rate into the mixing zone. Merely dribbling it into the water supply without careful control is not acceptable and, instead, accurate metering of the polymer is required so as to ensure both cost effective and approved application and the desired beneficial results of this, without incurring disadvantages due to accidental underdosing or overdosing.

Because of the high flow rate and high pressure of the water supply and the very low dosage that is required, it is necessary to use metering pump apparatus that is con-